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The Link Between Global Value Chain Activity and Local Human Capital: Evidence from Indonesia's Manufacturing Sector

Rashesh SHRESTHA[*]

Economic Research Institute for ASEAN and East Asia, Indonesia

Deborah WINKLER[†]

Global Economic Policy LLC, United States

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Abstract: *For developing countries, participation in global value chains (GVCs) provides an opportunity to expand domestic human capital. Since GVC firms require qualified workers to meet high production standards, they have an incentive to invest directly in their workers' skills or to raise the demand for skilled workers, which indirectly creates an incentive for workers to enrol in vocational education. This paper explores the relationship between GVC activity and workers' skills in Indonesia. It combines National Labor Force Survey (SAKERNAS) data with the Large/Medium Industry Survey (IBS) to construct a pooled cross-sectional data set of Indonesian manufacturing workers which takes into account measures of GVC activity at the district-sector-year level. The findings suggest that higher GVC activity in a worker's district-sector-year is linked to a higher likelihood of vocational education of individual workers. A separate panel data analysis at the district level confirms the positive relationship between GVC activity and human capital. Finally, the results indicate that the wage premium for vocational education is higher in districts with greater intensity of GVC activity.*

Keywords: Global value chain, human capital, Indonesia

JEL classification: F16, F66, J24

[*] Corresponding author: Rashesh Shrestha. Economic Research Institute for ASEAN and East Asia (ERIA)
Sentral Senayan II, 5-6th floor, Jl. Asia Afrika No.8, Gelora Bung Karno, Senayan, Jakarta Pusat 10270, Indonesia. *Email*: rashesh.shrestha@eria.org.
[†] Global Economic Policy LLC, Brooklyn, New York, United States. *Email*: deborah.winkler@gmail.com.
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1. Introduction and Motivation

One of the main reasons why policymakers in developing countries foster global value chain (GVC) participation – for instance, by lowering tariffs and incentivising foreign direct investment (FDI) – is to raise domestic productivity. FDI firms can improve domestic firms' productivity through spillovers resulting from knowledge diffusion, encompassing both technology and all forms of codified and 'tacit knowledge' related to production (Hoekman and Javorcik, 2006). The increase in domestic firm productivity due to FDI can be attributed to gains in workers' skills, at least in the medium to long term.[1] Similarly, GVC participation can increase workers' skills through several transmission channels (e.g. see Farole, Staritz, and Winkler (2014) and Taglioni and Winkler (2016)).

The most direct channel is that workers gain GVC industry-specific skills. GVC firms operating in developing countries need to ensure that their workers have the skills to comply with global quality standards that global lead firms impose (World Economic Forum, 2015; Criscuolo and Timmis, 2017). While global lead firms often source from suppliers or contract manufacturers in low-cost countries, most final goods are still destined for developed consumer markets and are therefore subject to high levels of quality control. Advanced workers' skills may also be necessary to operate machines or use imported inputs in GVC sectors. To meet these demands, firms participating in GVCs can thus directly train their workers or hire more skilled workers. From a worker's perspective, the prospect of employment in a GVC firm that pays higher wages could encourage workers to voluntarily obtain skills that will increase their chances to be hired. Both forces increase the supply of skilled workers in the economy.[2]

[1] In the short term, it is rather likely that foreign investors will bid away high-quality labour from domestic firms by offering higher wages and benefits, resulting in potentially negative spillover effects (e.g. Hoekman and Javorcik, 2006; Crespo and Fontoura, 2007).

[2] Besides spillovers through training, supply-chain linkages, and demand, GVC participation-induced competition can force domestic firms to raise the productivity of their workforce, not only those operating in the same sector as the foreign investor or buyer, but also those in supplying sectors as they are seeking to become a supplier (spillovers through competition). Likewise, such training may have broader spillover effects by increasing the human capital of the economy, as formerly trained workers may move to other firms or decide to start their own companies (spillovers through labour turnover).

In this paper, we explore the relationship between GVC participation and human capital in Indonesia's manufacturing sector. Indonesia has limited GVC participation, which is highly concentrated in a few regions and sectors. This is to be expected, given Indonesia's endowment of natural resources and agroclimatic suitability for the production of commodities such as oil palm and rubber. While Indonesia's manufacturing sector had performed well up to the Asian financial crisis of 1997/1998, the country's growth in the 2000s has been fuelled by the commodity boom and characterised by a lagging manufacturing sector. Over-reliance on primary commodities can diminish the opportunity for skill accumulation, which is necessary to reorient the economy towards skilled production and exports (Romalis, 2004). In such a context, GVC participation can help provide higher-value formal jobs and skills – providing a potential pathway out of commodity dependence. Indonesia is thus an interesting setting to study the relationship between GVC integration and workers' skills.

To conduct our analysis, we combine annual data from the Indonesian Large/Medium Industry Survey (IBS) with workers' characteristics from the National Labor Force Survey (SAKERNAS).[3] This forms a pooled cross-sectional data set, with information about workers' characteristics and GVC activity at the district[4]-sector-year level. Human capital is measured by the worker's vocational education. This paper finds that workers employed in a manufacturing sector and district with a larger intensity of GVC activity are more likely to have a vocational education. The positive link with vocational education is robust and consistent across different specifications. We also perform a separate panel data analysis at the district level, which confirms this positive relationship. Furthermore, to examine how GVC activity affects the wage premium for vocational education in manufacturing, we estimate a set of wage regressions in which we progressively restrict our sample to higher GVC activity locations, controlling for the general level of local manufacturing activity. We find that the wage premium for vocational education is higher in districts with greater

[3] Details of the survey can be found on the web page of Statistics Indonesia (Badan Pusat Statistik, n.d.).
[4] The *kabupaten/kota* (district) is the second subnational administrative unit after province. As of 2018, Indonesia had more than 500 districts, classified as regencies (N=416) and municipalities (N=98).

intensity of GVC activity, and that it has increased from 2008 to 2015 – suggesting a demand effect from GVC activity.

Our main contribution is a direct analysis of the relationship between GVC participation and human capital. There are several reasons why such a study is warranted. First, while the literature on the existence of productivity spillovers is vast, there is a gap of studies assessing the underlying transmission channels. This paper provides evidence for the role played by workers' skills and complements existing evidence on productivity spillovers from FDI or GVC participation through the training or skills channel, which is rare and seems to be limited to firm-level surveys or anecdotal evidence. Amongst existing studies, an analysis based on the World Bank Enterprise Surveys for 29,000 manufacturing firms in 64 countries found that firms which offer training for workers pay higher average wages (which could serve as a proxy for workers' skills), but the study did not disentangle the effects of FDI or GVC participation (Rocha, Shepherd, and Winkler, 2020). Using unique survey data on direct supplier–FDI linkages in Chile, Ghana, Kenya, Lesotho, Mozambique, Swaziland, and Viet Nam, Winkler (2018) found that suppliers whose workforces had received training from FDI firms, as part of their supplier relationship, were more likely to start exporting at a later stage. Other studies have found evidence of higher productivity of workers or entrepreneurs with previous work experience in GVC firms, but have not focused on training per se as a determinant of their skills acquisition (e.g. Balsvik (2011) or Görg and Strobl (2005)).[5]

Second, this paper is linked to the strand of literature on the effects of trade and trade liberalisation on workers' skills. From an advanced country perspective, offshoring (importing) of low-skill-intensive tasks could lower the relative demand for unskilled labour and increase the relative demand for skilled labour (see seminal studies by Feenstra and Hanson 1996, 1999; and many follow-up studies). However, empirical reality is more complicated in developing countries. While neoclassical trade

[5] Balsvik (2011), for instance, found that employees in Norwegian manufacturing firms with previous work experience in multinationals contributed 20% more to productivity than their counterparts without such experience, and that this seemed to be driven by less-skilled workers. Similarly, Görg and Strobl (2005) found for a sample of manufacturing firms in Ghana that domestic entrepreneurs with previous work experience in a multinational firm in the same industry ran more productive firms than entrepreneurs without such experience, especially for entrepreneurs with a lower educational level. The explanation given is that the entrepreneurs' capacity to absorb new knowledge is larger for individuals with a lower educational level because of the steeper learning curve they face.

theory predicts increased demand for low-skilled workers, skilled workers are often the main beneficiaries of GVC integration (e.g. Attanasio, Goldberg, and Pavcnik, 2004; Goldberg and Pavcnik, 2007; Kasahara, Liang, and Rodrigue, 2016). The higher wage premium for skills observed in GVC-oriented locations found in this study adds to the mounting evidence that workers' skills are an important determinant of the benefits from globalisation.[6]

Several studies have focused on Indonesia's experience with trade liberalisation and its relationship with skills. A recent study by Kasahara, Liang and Rodrigue (2016) confirmed that firms which import inputs are more likely to rely on workers with higher levels of education. Likewise, importers in Indonesia tend to spend more per worker on training and invest more in research and development (Kasahara, Liang, and Rodrigue, 2016). One explanation offered in this study is that importing intermediate inputs is akin to a skill-biased technological change in the firms' production technology, which is complementary to skilled labour. Amiti and Davis (2012) also found that importing firms in Indonesia tend to pay higher wages than domestic-oriented firms when input and output tariffs are lowered. The relationship between trade liberalisation and skills also depends on the supply of low-skilled labour and a country's development stage. Amiti and Cameron (2012) found for Indonesia that tariff reductions lowered within firm skill premiums. The authors attributed these unexpected findings to the larger unskilled labour base and earlier development stage of Indonesia compared with other countries where similar studies had been conducted. We add to this literature by studying how Indonesia's participation in GVCs has affected workers.

This paper is structured as follows. The next section gives an overview of Indonesia's participation in GVCs and the development of human capital, hypothesising that both are linked. Section 3 introduces the empirical model, data, and measures used, while section 4 discusses the results. Finally, section 5 concludes.

[6] Assuming a productivity-based wage setting, our paper also relates to the strand of literature on the productivity effects from trade and trade liberalisation. It has been well established in the empirical literature that firms' trade and productivity are positively linked (Bernard and Jensen, 1999). This may happen through self-selection of highly productive firms into exporting (Melitz, 2003), learning by exporting (De Loecker, 2013), or cheaper access to high-quality intermediate inputs (Amiti and Konings, 2007). Amiti and Konings (2007) found that liberalising input tariffs has much larger productivity gains than liberalising final goods tariffs.

2. Global Value Chain Participation and Human Capital

Trade within international production networks has played an important role in the expansion of international trade over the past three decades, with many developing countries entering GVCs. One important advantage offered by GVCs is the opportunity to participate in skill-intensive manufacturing production. This is usually not the case for countries such as Indonesia, which are endowed with less-skilled labour and have abundant natural resources. The Heckscher–Ohlin model of international trade predicts that, consistent with their factor endowments, these countries are more likely to specialise in low-skilled manufacturing production and exports.[7]

While the previous argument is based on final goods trade, GVC participation and human capital have a positive relationship in developing countries. Although the skills composition of the workforce plays an important role in determining what types of GVC activity take place in a country or region (Grundke et al., 2017), even the least-skilled activity within a GVC tends to require more skills than non-GVC-related tasks in developing countries. As a result, although there is some heterogeneity, GVC-oriented firms tend to be more productive than non-GVC firms (World Bank, 2019). Thus, a higher extent of GVC activity tends to increase demand for skilled workers, for example, to complement the use of advanced inputs or to comply with higher quality and production standards. When the distribution of GVC activity is concentrated in a particular sector or location within a country, we expect suitably skilled workers to be concentrated in those sectors or locations. This relative increase in skilled workers could be due to local skills acquisition or the migration of skilled workers from other locations or sectors.

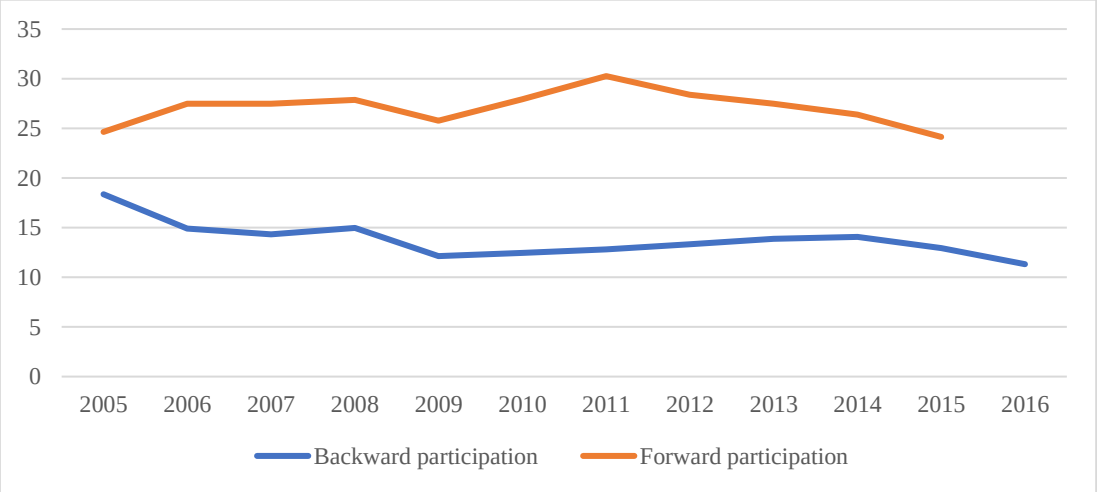
2.1. GVC participation in Indonesia

Indonesia, as a whole, has a relatively low level of GVC participation, as indicated by its higher proportion of trade in final goods and domestic value-added share in exports, compared with other middle-income countries in the region. Figure 1 shows trends in Indonesia's GVC participation from 2005 to 2015 (for forward

[7] A large body of theoretical trade literature predicts a correlation between factor endowment and factor intensity of exports and production. See, for example, Romalis (2004).

participation) and 2016 (for backward participation). During this period, Indonesia's foreign value added – embodied in its gross exports (backward GVC participation in levels) – increased by an average of 2.6% per year, compared with 41.8% for Viet Nam and 16.1% for India. Indonesia's overall foreign value-added content in gross exports, expressed as a percentage of total gross exports (backward GVC participation in shares), is small (about 13% in 2015), especially when compared with forward GVC participation (Figure 1). The low backward participation could be attributed to the large size of Indonesia's domestic economy and restrictions in service imports. The forward GVC participation share of around 24% shows that a large share of Indonesia's exports is being used in the export production of Indonesia's partner countries, reflecting its reliance on commodity exports.

Figure 1: Total GVC Participation Measures in Indonesia, 2005–2015/2016

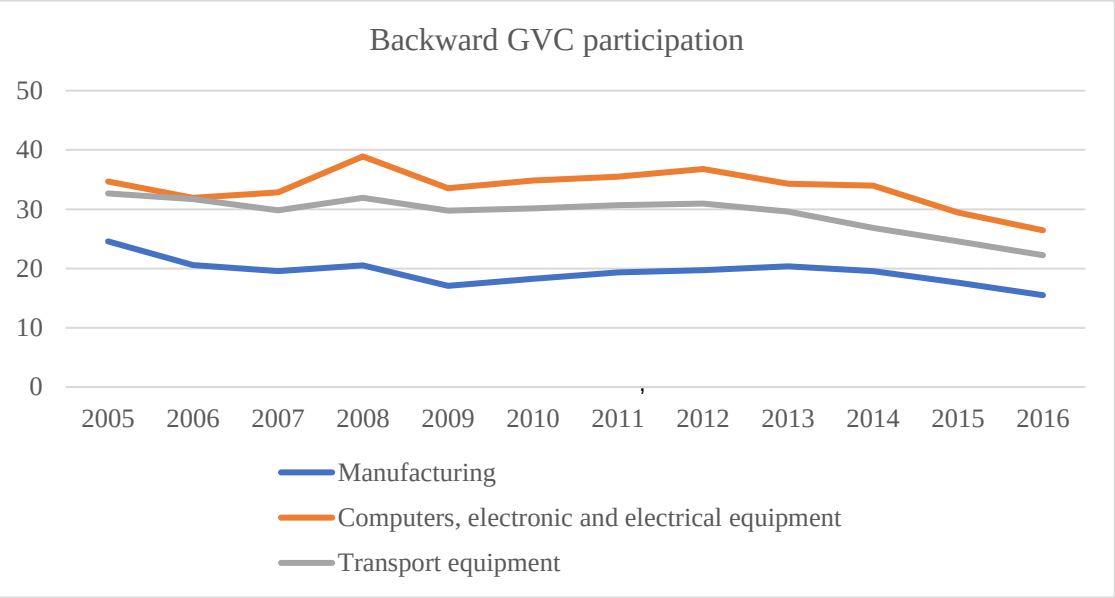


GVC = global value chain, OECD = Organisation for Economic Co-operation and Development, TiVA = Trade in Value Added.
Note: 2016 data are based on OECD estimates.
Source: OECD TiVA, 2018 release.

Nonetheless, there are pockets of high-level GVC activity. Comparing across sectors, the largest backward GVC participation is found in technology-intensive manufacturing of transport equipment; and manufacturing of computers, electronics, and electrical equipment. Both are prominent GVC sectors for Indonesia and are heavily influenced by Japanese lead firms (Ing, Hanson, and Indrawati, 2017). The backward participation rate in 2016 was 26% for computers and electronics and 22% for transport equipment (Figure 2), compared with 61% and 52%, respectively, in

Viet Nam in the same year. Participation has been declining sharply since 2012, when the imported input shares of exports were 36% and 33%, respectively, in these two sectors. During this period, employment shares of these sectors have risen. For example, the percentage of workers in motor vehicles and other transport equipment (International Standard Industrial Classification of All Economic Activities (ISIC) codes 34 and 35) increased from 3.44% to 4.85% from 2008 to 2015. Likewise, the manufacture of machinery and equipment[8] saw a slight increase in the employment share from 6.2% to 6.6%. Amongst the labour-intensive sectors, 22% of the gross exports of the textiles and apparel sector consisted of foreign value added.

Figure 2: GVC Participation Measures in Manufacturing in Indonesia, 2005–2016



GVC = global value chain, OECD = Organisation for Economic Co-operation and Development, TiVA = Trade in Value Added.
2016 data are based on OECD estimates.
Source: OECD TiVA, 2018 release.

[8] This includes the following ISIC sectors: manufacture of machinery and equipment n.e.c. (29); manufacture of office, accounting, and computing machinery (30); manufacture of electrical machinery and apparatus n.e.c. (31); manufacture of radio, television, and communication equipment and apparatus (32); and manufacture of medical, precision and optical instruments, watches, and clocks (33).

FDI, which is an important aspect of GVC participation in developing countries, rose in the 2000s as the economy opened up and foreign ownership rules were relaxed. Much of the FDI is still concentrated in mining and non-tradable sectors, but the metal, machinery, and electronics sector received 10.6% of FDI inflows in 2015. Table 1 shows the proportion of medium-sized and large manufacturing firms that are foreign-owned (using a 10% threshold in ownership share). Over 2005–2015, about 9% of medium-sized and large firms in Indonesia's manufacturing sector were foreign-owned. Such foreign-owned firms are larger and produce more output, as reflected in their higher average shares in total employment (27%) and value added (41%) over this period. From 2005 to 2011, the share of employment in foreign-owned firms increased by 7 percentage points and has remained relatively constant since then. This indicates that domestic employment in GVC-oriented activities likely also increased during this period. While the value-added share of foreign-owned firms rose strongly from 2005 to 2010, from 34% to 49%, it fell sharply afterwards to below 40%.

Table 1: Share of Foreign-Owned Firms, 2005–2015

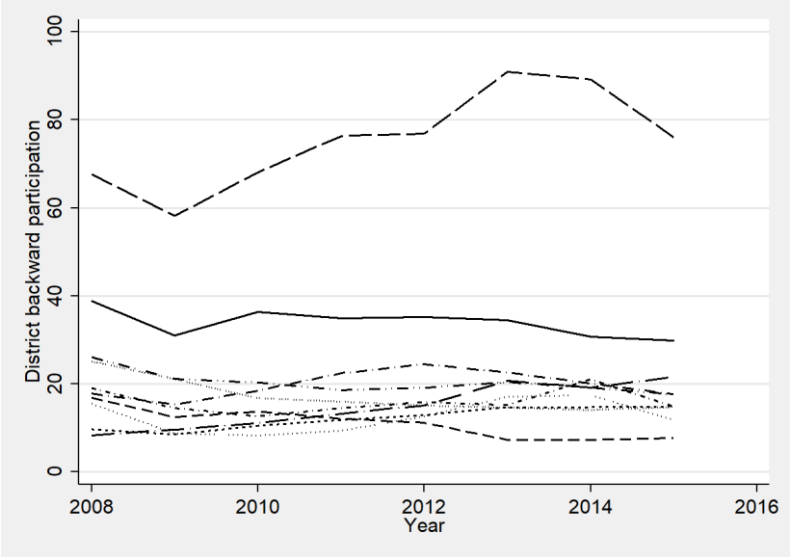
Year	(1) Unweighted	(2) Employment weighted	(3) Value added weighted
2005	0.08	0.22	0.34
2006	0.07	0.24	0.37
2007	0.08	0.25	0.37
2008	0.08	0.28	0.46
2009	0.09	0.28	0.47
2010	0.09	0.29	0.49
2011	0.09	0.29	0.44
2012	0.09	0.28	0.39
2013	0.09	0.27	0.36
2014	0.10	0.27	0.41
2015	0.10	0.29	0.39
Total	**0.09**	**0.27**	**0.41**

IBS = Survei Industry Besar/Sedang (Large/medium industry survey).
Note: Column 1 shows the number of firms, column 2 reflects the weight by employment, and column 3 shows the weight by real value added.
Source: Authors' calculations from the IBS.

In addition to being concentrated in a few sectors, GVC activity in Indonesia is heavily concentrated in certain locations. We do not have district-level data on GVC participation, but we can approximate them by applying the shift-share approach to national-level GVC participation indicators (the method will be discussed in detail in the next section). Applying this method, we identify the top districts for GVC participation during 2008–2015 and plot the intensity of participation in Figure 3a. The shift-share based measure of GVC participation shows high concentration in a few districts on Java island. Compared with the average backward GVC participation of manufacturing sectors (16% in 2015), Indonesia's average district participation index is just under 1%, while the top district has an index of 76%. This is because many manufacturing sectors, characterised by high GVC participation, are located within the same district. In Indonesia's case, Bekasi regency had the highest participation in 2015, followed by Batam island.

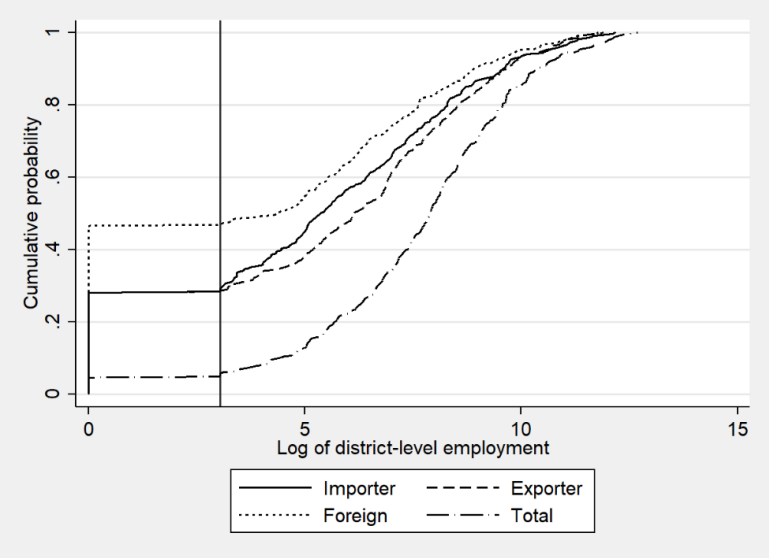
Like manufacturing activity in general, foreign-owned firms are also concentrated in a few locations and sectors. This is shown in Figure 3b, which shows the distribution of district-level employment in medium-sized and large importer firms, exporter firms, foreign-owned firms, and all firms for 2015. The largest proportion of districts has no employment in foreign firms. These locations are likely to have greater concentration of skilled workers.

Figure 3a: Evolution of GVC Backward Participation in Top Participating Districts



GVC = global value chain, IBS = Survei Industri Besar/Sedang (Large/Medium industry survey), OECD = Organisation for Economic Co-operation and Development, TiVA = Trade in Value Added.
Note: Top districts are defined as those that achieved top 5 ranking in GVC participation anytime during 2008–2015.
Source: Authors' calculation from OECD TiVA and IBS data.

Figure 3b: Distribution of District-Level Employment by Firm Type, 2015



IBS = Survei Industri Besar/Sedang (Large/Medium industry survey).
Notes: The vertical line indicates the employment size of 20 (in logs), the minimum threshold for inclusion of a firm in the IBS. Employment size in logs. Source: Authors' calculation from IBS 2015 data.

2.2. Human capital in Indonesia

Indonesia's pattern of human capital development can be gleaned from the SAKERNAS data. The attainment of upper secondary education,[9] in both the general and vocational track, has been increasing steadily. The proportion of individuals aged 20–65 whose highest completed education was vocational schooling was 7% in 2008, which increased to 11% in 2015. The youngest workers are most likely to have vocational education: amongst those aged 20–29 who were likely to have recently entered the labour market, the share of vocational education increased from 10% in 2008 to 17% in 2015. The proportion of workers with vocational schooling increased from 12% in 2008 to 17% in 2015 in the manufacturing sector; the increase is 7 percentage points amongst younger workers, from 17% to 24%.

Vocational education has gained renewed attention in Indonesia. After steadily increasing in the 1990s, the number of vocational students was declining until 2006, as market incentives for enrolling in vocational school were not attractive. Newhouse and Suryadarma (2011) analysed the returns to vocational training and found mixed

[9] Upper secondary education refers to more than 9 years of schooling. Indonesian law mandates 9 years of compulsory education. In Indonesia, individuals aged 15 choose between a general and vocational education track, with little overlap in the two curricula.

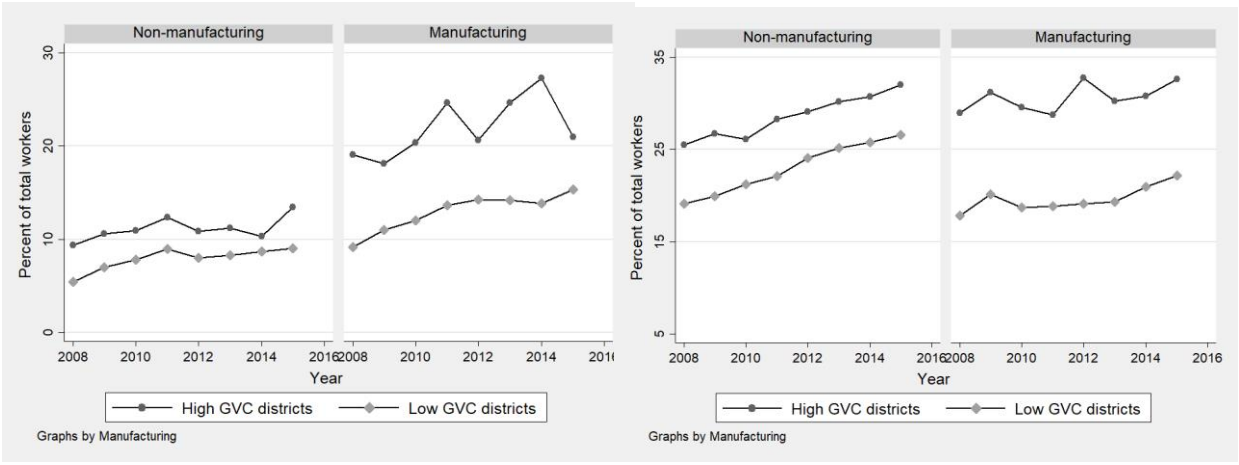
results. According to their results, men faced a wage penalty for enrolling in vocational school. Nonetheless, in 2009, the Indonesian Ministry of Education sought to expand the share of vocational students by limiting the construction of new general high schools and converting existing ones to vocational institutions.[10] These supply-side policies cannot be fully effective without strong demand for workers with vocational education. Thus, Indonesia's participation in GVCs could have complemented a push by policymakers towards greater vocational education.

The relationship between human capital and GVC activity is evident in districts with high intensity of GVC activity, as depicted in Figure 4. The figure shows trends from 2008 to 2015 in the share of vocational and trained workers in the manufacturing and non-manufacturing sectors in high and low GVC-intensive districts. It shows that the share of vocational workers in the manufacturing sector was quite high in 2008 to begin with, compared with that of manufacturing workers in low GVC-intensive districts and that of non-manufacturing workers in general. In addition, the rate of increase in the share of workers with vocational education is quite high in high GVC-intensive districts from 2009 to 2011 and from 2012 to 2014.[11] While the share of workers with vocational education in low GVC-intensive districts has also risen amongst manufacturing workers, the growth is not as fast.

[10] According to official statistics, the number of villages with vocational education increased from 5,000 in 2008 to 8,500 in 2014. Figure A1 in the appendix depicts the expansion of vocational education in Indonesia. While fewer than 30% of the districts had more than 1.5 schools per 10,000 families in 2008, the share rose to 55% by 2014. In academic year 2014/15, 4.3 million students were enrolled in vocational schools, taught by 260,000 teachers. The number of students enrolled in vocational and senior high schools was about the same.

[11] We do observe a dramatic drop in shares in 2012 and 2015, although it is not clear why that is the case.

Figure 4: Share of Vocational Educated Workers by Sector and GVC Intensity



GVC = global value chain, IBS = Survei Industri Besar/Sedang (Large/Medium industry survey).
Note: The figure shows workers' human capital by intensity of GVC activity and manufacturing/non-manufacturing sector. Panel (a) shows the percentage of vocational educated workers, and panel (b) shows the percentage of general senior-level educated workers. Source: Authors' calculation from Sakernas and IBS data, 2008–2015.

3. Empirical Model and Data

While the previous section suggested a relationship, this section introduces our empirical model which allows us to assess the relationship between GVC participation and workers' skills econometrically. The analysis is conducted at both the individual worker level as well as the district level. For the individual worker level regressions, the main econometric specification takes the following form:

$$Y_{isjt} = \beta_0 + \beta_1 GVC_{sjt} + \alpha X_{isjt} + \gamma W_{sjt} + \theta_{sj} + \tau_t + e_{isjt} \quad (1)$$

where Y_{isjt} is a measure of the skills of worker i in sector s and district j at time t, GVC_{sjt} is the measure of GVC participation of sector s and district j at time t, X_{isjt} include individual worker characteristics controls such as age and gender, and W_{sjt} are time-varying characteristics of district-sector. Likewise, θ_{sj} and τ_t indicate district-sector (district only in some specifications) and time fixed effects. Standard errors are clustered at district-sector-year level or district-year level, depending on the model. In some specifications, we aggregate both Y_{isjt} and X_{isjt} up to the sector-district-year

level to estimate the model at that unit of analysis. Our analysis focuses on 2008–2015, mostly owing to the data availability of SAKERNAS.

3.1. Data sets

Since we do not have all the information we need in a single data set, we combine the SAKERNAS data, which contain labour market information at the individual level with information on GVC participation at the district-sector-year level, calculated from other data sources. SAKERNAS asks questions about workers' characteristics – including the highest level of education, sector, location,[12] and employment status, amongst others. We use this data set to obtain information about workers' skill levels. Since the survey does not indicate whether a worker is employed in a GVC-oriented firm, we combine this data set with other sources of information on firms' GVC activity at the district-sector level.

To calculate the magnitude of GVC activity, we use information derived from the IBS as well as the sectoral GVC participation indicators from the Organisation for Economic Co-operation and Development (OECD) Trade in Value Added (TiVA) database. The IBS data include all manufacturing firms with 20 or more employees.[13] The survey provides several relevant characteristics of the firms which proxy for GVC participation – their importing and exporting status, and foreign ownership share – but no detailed information about the workers' human capital.

Likewise, the TiVA data contain GVC measures at the sectoral level based on cross-country input–output relationships. The OECD TiVA database provides estimates of the value added by a country in the production of any good or service that is then exported, and offers a fuller picture of commercial relations between nations. The current 2018 edition covers 64 economies (including all OECD, European Union, and G20 countries; and most East and Southeast Asian economies) as well as region aggregates. Indicators are available for 36 industries within a hierarchy based on ISIC Rev. 4 for 2005–2015 (some 2016 estimates are available). By combining these

[12] During the study period, Indonesian districts underwent several subdivisions to create new districts. The location code in surveys is based on existing administrative boundaries. To create consistent district boundaries, we revert all locations to 2000 district boundaries by combining subdivided districts into parent districts.

[13] The information is available at the plant level, but a large majority of firms in Indonesia are single-plant firms.

different sources of information, we provide deeper insights into how GVC participation might influence human capital. Below is a more detailed description of the key measures and descriptive statistics.

3.2. Measures of GVC participation

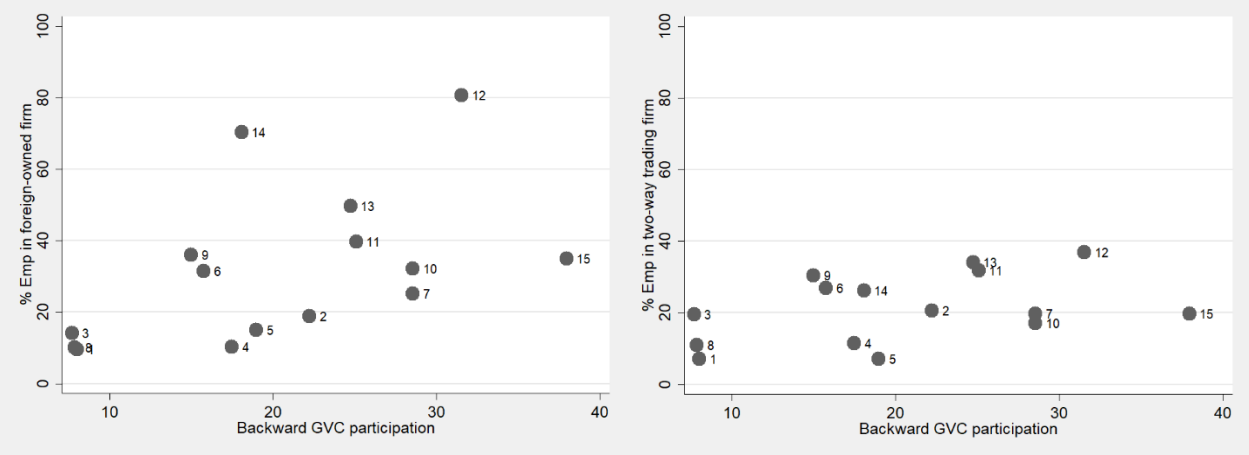
The main explanatory variable is the extent of GVC activity in a district-sector in a given year. We follow two approaches for this calculation. Our first approach is to measure GVC participation at the district-sector-year level based on the employment data of GVC-oriented firms. In the IBS data, we classify GVC-oriented firms in the data according to their ownership or trading status into foreign-owned firms and importer and exporter firms (two-way trading firms), but also include importer firms and exporter firms separately.[14] We define a district-sector as having greater GVC activity if it contains greater employment in firms that are foreign-owned and in firms that export and import.

The logic behind this approach is that these firm characteristics are strong predictors of participation in GVCs. First, developing countries' entry into GVCs is often driven by lead firms' FDI – as illustrated by Samsung's presence in Viet Nam, which is responsible for 40% of Samsung's global mobile phone products and the employment of 35% of its global staff (World Bank, 2019). Second, GVC participation is characterised by the concept of importing to export, i.e. GVC participants rely on imported components or inputs which they process and export (Baldwin and Lopez-Gonzalez, 2013).

Figure 5 shows the relationship between the OECD's GVC measure and the characteristics of manufacturing firms at the sectoral level. We find that sectors with higher levels of backward participation have greater shares of manufacturing employment in foreign-owned and in two-way trading firms. Thus, firm characteristics are good proxies for GVC activity in a district. Our GVC variables are measured both in employment levels (logs) and as a percentage of total employment.

[14] The classification is non-exclusive, so the same firm may appear in multiple categories. Such overlap does not pose a problem because these proxies for GVC participation are used in individual regressions.

Figure 5: Correlation Between Sectoral Backward GVC Participation and Firm Characteristics



(a) Foreign-owned firms

(b) Two-way trading firms

GVC = global value chain, IBS = Survei Industri Besar/Sedang (Large/Medium industry survey), Emp=Employment.Notes: Each dot represents a sector. The sector codes are as follows: 1. Food products, beverages, and tobacco; 2. Textiles, wearing apparel, leather, and related products; 3. Wood and products of wood and cork; 4. Paper products and printing, publishing, audiovisual, and broadcasting activities; 5. Coke and refined petroleum products; 6. Chemicals and pharmaceutical products; 7. Rubber and plastic products; 8. Other non-metallic mineral products; 9. Basic metals; 10. Fabricated metal products; 11. Machinery and equipment, not elsewhere classified, other manufacturing; repair and installation of machinery and equipment; 12. Computer, electronic, and optical products; 13. Electrical equipment; 14. Motor vehicles, trailers, and semi-trailers; 15. Other transport equipment.
Source: Authors' calculation from the OECD TiVA data and IBS.

Table 2 shows the proportion of importer, exporter, and two-way trading firms from 2005 to 2015. Until 2013, each type of firm increased in proportion to the total number of firms, with the largest increase in exporter firms (rising from 16% in 2005 to 21% in 2013). After 2013, however, the percentage of exporting firms declined to only 16% by 2015. Interestingly, the proportion of GVC-intensive firms is larger in terms of employment, suggesting that GVC-oriented firms create more jobs than non-GVC firms. From 2005 to 2013, the employment share of importer firms declined slightly from 47% to 43%, while that of exporter firms increased by 11 percentage points (but fell again in 2014 and 2015) and that of two-way trader firms increased by 5 percentage points.

Table 2: Share of Different Types of Firms by Year, 2005–2015

Year	(1)	(2)	(3)	(4)	(5)	(6)
	Unweighted			Employment weighted		
	Importer	Exporter	Two-way	Importer	Exporter	Two-way
2005	0.19	0.16	0.05	0.47	0.37	0.22
2006	0.18	0.18	0.05	0.42	0.45	0.24
2007	0.18	0.14	0.04	0.43	0.34	0.21
2008	0.17	0.15	0.05	0.42	0.35	0.21
2009	0.17	0.16	0.06	0.42	0.39	0.24
2010	0.18	0.19	0.07	0.43	0.45	0.27
2011	0.19	0.20	0.07	0.44	0.48	0.28
2012	0.21	0.20	0.07	0.43	0.47	0.27
2013	0.23	0.21	0.07	0.43	0.48	0.27
2014	0.23	0.18	0.06	0.45	0.43	0.26
2015	0.25	0.16	0.06	0.44	0.40	0.24
Total	**0.20**	**0.17**	**0.06**	**0.43**	**0.42**	**0.25**

IBS = Survei Industry Besar/Sedang (Large/medium industry survey).
Note: Columns 1–3 are unweighted; columns 4–6 are weighted by employment.
Source: Authors' calculation from the IBS.

Since we exploit variation in GVC activity across districts, we summarise the spatial distribution of GVC activity. Table 3 shows the location distribution of different types of firms, weighted by total employment. We find some variation in the location of different types of firms. West Java province hosts most of the GVC-oriented firms. More than a third of employment in foreign-owned firms in 2015 was located in this province, followed by Banten province with 14%. The shares are comparable for two-way traders (exporter and importer firms). By contrast, only 30% of exporter firms are located in West Java, followed by almost 20% in Central Java, 17% in East Java, and over 11% in Banten.

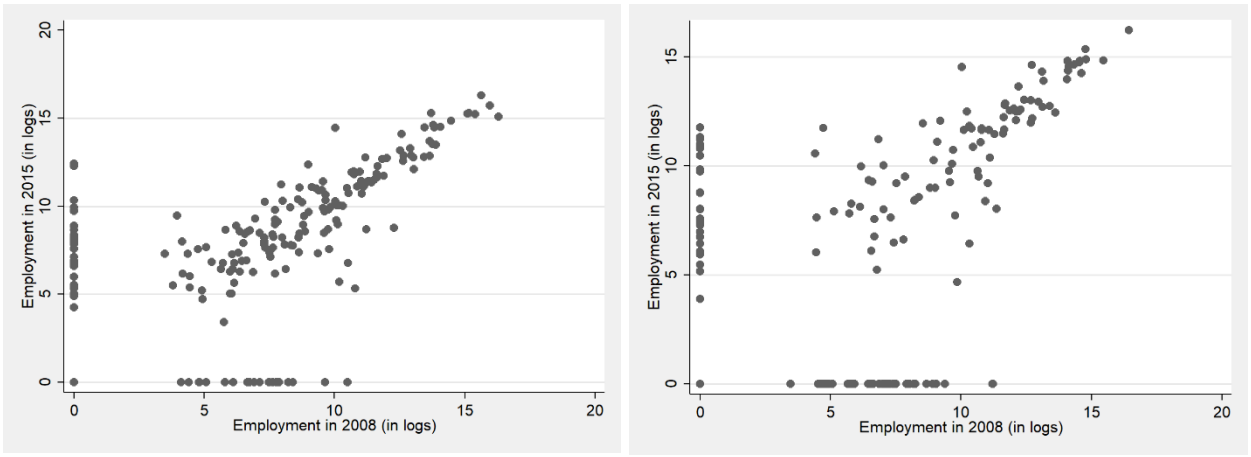
Table 3: Distribution of Firms Across Selected Provinces, 2015

Province	(1) Foreign-owned	(2) Two-way trader	(3) Importer	(4) Exporter
North Sumatra	2.13	1.68	1.47	1.94
Riau Islands	8.04	5.11	4.20	3.55
DKI Jakarta	7.29	6.24	6.54	5.53
West Java	36.82	34.55	38.50	29.81
Central Java	13.58	18.54	14.71	19.66
Yogyakarta	0.83	1.37	1.00	1.57
East Java	10.23	14.72	15.13	17.17
Banten	14.06	14.10	13.24	11.79
Rest of Sumatra	3.56	1.72	2.29	4.08
Rest of Indonesia	3.47	1.98	2.92	4.91
Total	**100.00%**	**100.00**	**100.00**	**100.00**
Number of firms	2,621	1,550	6,602	4,222

DKI Jakarta = Jakarta Capital Region.
Note: Weighted by employment.
Source: Authors' calculation.

One fact about Indonesia's manufacturing activity is that locations of GVC-oriented firms have not changed significantly over time. There is a strong positive correlation in district-level GVC activity, as illustrated in Figure 6, which shows a correlation in district-level employment in 2008 and 2015 in foreign-owned (Panel A) and two-way trader (Panel B) firms. However, some districts gained in GVC activity: for instance, amongst the 172 districts that had zero employment in foreign-owned firms in 2008, the average employment in foreign-owned firms increased to 3,600 by 2015. The districts with the highest gains in foreign-owned employment were located on Java island.

Figure 6: Correlation Between District-Level Total Employment (in Logs) in 2008 and 2015 in Different Types of Firms



Notes: Total employment is converted to logs after adding 1 to account for zero employment in the given firm type. District boundaries are based on the 2000 administrative division to account for the change in administrative boundaries over time.
Source: Authors' calculation from Survei Industri Besar/Sedang (Large/Medium industry survey)data.

Our second approach is to compute GVC activity in a district based on the district's share of employment in GVC-intensive sectors, where GVC intensity is calculated as the sector's backward participation rate. To calculate district j's share of national employment in sector s, we multiply the sector s employment in district j with (national-level) GVC measures in sector s, which is the standard shift-share approach used in the trade literature to create subnational estimates of GVC participation measures (e.g. Amiti and Konings, 2007). Basically, the GVC activity in district j at time t, gvc_{jt}, is given by

$$gvc_{jt} = \sum_{s} gvc_{st} * \omega_{jst}$$

where gvc_{st} is the sector-level GVC participation measure at time t and ω_{jst} is district j's employment share in sector s at time t. We focus on the measure of backward GVC participation.

For this computation, we rely on the OECD TiVA data. To match the GVC data with IBS and SAKERNAS, we create a concordance between the ISIC Rev. 3 and TiVA database for the manufacturing sectors. The 22 ISIC Rev. 3 manufacturing industries are classified into 15 more aggregate sectors.[15] We then calculate the GVC intensity of a district by multiplying the backward participation of the industry by the employment share in different types of firms.

3.3. Measuring human capital

One of the limitations of current literature on trade and skills is the conflation of skills and years in general schooling (e.g. Kasahara, Liang, and Rodrigue, 2016), usually owing to data limitations. The main drawback in the context of emerging economies is that years of general education may be affected by policies such as higher compulsory education laws. If younger workers tend to be more educated due to policy change, and more likely to enter the expanding tradable sector due to greater mobility, then one may misleadingly conclude that the tradable sector has greater demand for skills. Similarly, general education is usually geared towards the academic track, while many emerging economies specialise in output requiring mid-level skill acquisition. Such skills are more directly acquired through specialised vocational schools, which may not be reflected in years of general education. The vocational track is usually separate and runs in parallel to the general education track, with individuals having to choose between one or the other after lower secondary level.[16]

Thus, in the context of a developing country in particular, directly exploring the acquisition of skills is very important. This study therefore uses a measure of vocational schooling which is less prone to suffer from this problem. SAKERNAS asks respondents about their highest level of education, with vocational junior or vocational senior as two possible answers. We construct an indicator variable which

[15] The concordance table is available upon request. The recycling sector, which is present in Indonesian firm data, is dropped from the analysis.
[16] Even when studies use other measures of skills, such as production vs. non-production workers in Amiti and Cameron (2012), it does not get at the issue of skills acquisition by production workers, which may be driving the reduction in wage premiums found by the authors.

takes a value of 1 if the individual's highest grade completed was vocational schooling.[17]

3.4. Other control variables

In addition to the location-sector and year fixed effects, we control for time-varying characteristics of district-sector, which include total employment in large and medium-sized enterprises. Since Indonesia experienced policy-induced vocational school growth during this period, we also control for a measure of district-level supply of vocational schools. Using the Village Potential Survey (PODES) data set, we calculate the proportion of families in the district who live within 5 kilometres of a vocational school. Since the PODES only covers 2008, 2011, and 2014, the values for rest of the years are imputed by assuming piecewise linear growth in the variable during the 2008–2011 and the 2011–2015 periods separately.

Table 4 shows the summary statistics (means) of the SAKERNAS data for 2008, 2011, and 2015. The average worker in 2015 is around 38 years old, and 56% of workers are men. The percentage of workers with a vocational education is 15%, while 23% have senior or higher education. Only 2% of the workers surveyed worked in machinery and transport equipment each.

Table 4: Summary Statistics of Workers in the Manufacturing Sector

Variable	2008	2011	2015
Age	35.12	37.05	38.12
Male	0.56	0.57	0.56
Received training	0.08	0.06	0.05
Has vocational education	0.12	0.14	0.15
Has senior or above education	0.22	0.21	0.23
Machinery subsector worker	0.05	0.03	0.02
Transport equipment subsector worker	0.02	0.02	0.02

Source: Authors' calculation based on data from SAKERNAS.Results

[17] SAKERNAS also asked whether the worker received any formal job training, which is another important aspect of skills development. However, we found training to have become less important over time, as the share of workers with training fell sharply from 2008 to 2015.

This section reports the results of a linear probability model, with dummy variables of worker human capital as the dependent variable and GVC activity as the explanatory variable. Each column in the results tables pertains to different measures of GVC activity. Such GVC activity is measured by a district-sector's employment in foreign-owned firms (column 1), importing and exporting (two-way trading) firms (column 2), importing firms (column 3), exporting firms (column 4), and a district's backward GVC participation based on the shift-share approach (column 5). All regressions control for workers' sex (male dummy); age (age group dummies); and include district, sector, and time fixed effects. All specifications also control for a district-sector's total employment (in logs) in medium-sized and large manufacturing firms, and the density of vocational schools in the district, as well as year fixed effects.

3.5. GVC participation and individual vocational education

Table 5 reports the results, using vocational education as a measure of an individual worker's skills as the dependent variable. The results are strongest and similar in magnitude in specifications that measure GVC activity based on employment in foreign-owned firms, two-way trading firms (columns 1 and 2), and backward GVC participation using the shift-share approach (column 5). A 10% increase in employment in foreign-owned firms and two-way trading firms in the worker's district-sector is related to a higher likelihood of vocational training by 3.4 and 2.9 percentage points, respectively. This indicates a strong overlap in these proxies of GVC activities. Interestingly, the correlation is slightly smaller for exporters (column 3) as compared to importing firms (column 4).

Table 5: GVC Participation and a Worker's Likelihood of Having Vocational Education, 2008–2015

Variable	(1) Foreign-owned	(2) Importer & exporter	(3) Exporter	(4) Importer	(5) GVC backward
GVC measure	0.0034***	0.0029***	0.0014**	0.0018***	0.0024**
	(0.00067)	(0.00066)	(0.00067)	(0.00069)	(0.0010)
Log (Emp M&L)	0.0027***	0.0031***	0.0034***	0.0034***	0.0046***
	(0.00078)	(0.00076)	(0.00091)	(0.00082)	(0.00072)
Voc density	-0.0011***	-0.0011***	-0.0011***	-0.0011***	-0.0012***
	(0.00033)	(0.00033)	(0.00033)	(0.00033)	(0.00033)
Age group					
30–44	-0.041***	-0.041***	-0.041***	-0.041***	-0.041***
	(0.0033)	(0.0033)	(0.0033)	(0.0033)	(0.0033)
45–59	-0.086***	-0.086***	-0.087***	-0.087***	-0.087***
	(0.0035)	(0.0035)	(0.0035)	(0.0035)	(0.0035)
>60	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***
	(0.0041)	(0.0041)	(0.0041)	(0.0041)	(0.0041)
Male	0.053***	0.053***	0.053***	0.053***	0.053***
	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)
Location FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes
Observations	76,488	76,488	76,488	76,488	76,488

Emp M&L = total employment in medium-sized and large enterprises in the district; FE = fixed effects; GVC = global value chain; Voc density = vocational school density.
Notes: Standard errors (in parentheses) are clustered at the location-year-sector level. * p<.1, ** p<.05, *** p<.01. The reference group for the age group is 15–29 years. Column headings indicate the measure of GVC-oriented firms.
Source: Authors' computations. Data: SAKERNAS and IBS.

Note also that employment in medium-sized and large firms in a district-sector shows a positive and significant correlation with the likelihood of having vocational education. That is, the presence of such manufacturing firms themselves has a positive effect on the likelihood of the worker receiving vocational training. GVC activity

further increases this likelihood. The density of vocational schools in a district, by contrast, shows a negative link with the probability of a worker having vocational education. Although this is counterintuitive, it could be due to a few reasons. Since we use imputed values of vocational education, there could be strong autocorrelation.[18] Another possibility is that vocational schools tend to be located in residential areas, whereas GVC firms are usually clustered around locations such as industrial parks. The coefficients on age group dummies are negative and large, indicating that the youngest workers in the base category (15–29 years) are most likely to have received vocational education. Likewise, the probability of male workers having vocational education is 5 percentage points higher than for female workers.

As robustness checks, we use alternative calculations of GVC activity in a location/sector. First, we use shares of employment in GVC-oriented firms in a location-sector rather than numbers (in logs). Second, we use the total output of, rather than employment in, GVC-oriented firms as a proxy for GVC activity. The results for foreign-owned firms and two-way trading firms are presented in Table 6. The first two results columns use output and employment shares of foreign firms as a measure of GVC, while the last two results columns use output and employment shares of two-way trading firms. The results remain robust – in both cases, we find a strong relationship between GVC activity and vocational education.

[18] As a robustness check, we exclude the years for which no vocational school density information is available, but the results do not change.

Table 6: GVC Participation and a Worker's Likelihood of Having Vocational Education, 2008–2015, Alternative GVC Measures

Variable	Foreign		Importer & exporter	
	(1) Output	(2) Employment share	(3) Output	(4) Employment share
GVC measure	0.0013***	0.00042***	0.0012***	0.00049***
	(0.00023)	(0.000086)	(0.00023)	(0.000090)
Log(Out M&L)	0.00098***		0.0011***	
	(0.00027)		(0.00027)	
Voc density	-0.0011***	-0.0011***	-0.0011***	-0.0011***
	(0.00033)	(0.00033)	(0.00033)	(0.00033)
Log(Emp M&L)		0.0034***		0.0032***
		(0.00075)		(0.00074)
Location FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes
Observations	76,488	76,488	76,488	76,488

Emp M&L = total employment in medium-sized and large enterprises in the district; FE = fixed effects; GVC = global value chain; Out M&L = output of medium-sized and large firms; Voc density = vocational school density.
Notes: Standard errors (in parentheses) are clustered at the location-year-sector level. * p<.1, ** p<.05, *** p<.01. Column headings indicate the measure of GVC activity.
Source: Authors' computations. Data: SAKERNAS and IBS.

We also analyse the impact of GVC activity, using the firm-based GVC measure amongst young workers only. This is shown in Table 7. The results are consistent with stronger coefficients. An increase in employment by 10% in foreign-owned medium-sized and large enterprises increases the likelihood of a young manufacturing worker possessing vocational education by 4.6%, compared with 3.4% for all workers. This suggests that GVC activity is inducing a greater tendency towards vocational education amongst younger workers. We find similar positive effects on the likelihood of senior education, indicating that GVC activity tends to be more skill-intensive in general (results are available from the authors).

Table 7: GVC Participation and a Worker's Likelihood of Having Vocational Education, 2008–2015, Young Workers

Variable	Foreign			Importer–exporter		
	(1) Emp	(2) Output	(3) Capital	(4) Emp	(5) Output	(6) Capital
GVC measure	0.0046***	0.0016***	0.0012***	0.0040***	0.0016***	0.0014***
	(0.0013)	(0.00044)	(0.00047)	(0.0012)	(0.00043)	(0.00046)
Log(Emp M&L)	0.0013			0.0018		
	(0.0016)			(0.0015)		
Voc density	-0.00092	-0.00093	-0.00091	-0.00089	-0.00092	-0.00090
	(0.00064)	(0.00064)	(0.00065)	(0.00064)	(0.00064)	(0.00064)
Log(Out M&L)		0.00091*			0.0011**	
		(0.00054)			(0.00053)	
Log(Cap M&L)			0.00069			0.00070
			(0.00057)			(0.00055)
Location FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,610	25,610	25,605	25,610	25,610	25,605

Cap = capital stock; Emp M&L = total employment in medium-sized and large enterprises in the district; FE = fixed effects; GVC = global value chain; M&L = medium-sized and large firms; Out = output; Emp = employment; Voc density = vocational school density.
Notes: Standard errors (in parentheses) are clustered at the location-year-sector level. * p<.1, ** p<.05, *** p<.01. Column headings indicate the measure of GVC activity.
Source: Authors' computations. Data: SAKERNAS and IBS.

3.6. District-level panel analysis

We also aggregate both the SAKERNAS and IBS data to the district level to create a district-level panel data set for 2008–2015, and estimate the relationship between worker skills and GVC activity. We specify a district-level skilled labour demand model, in which GVC activity in the district creates demand for vocational educated workers. The dependent variable is the number of workers (in logs) in a district with vocational education in the manufacturing sector, whereas the main

explanatory variable is a district's total output and capital stock (in logs) in manufacturing firms that are GVC-oriented foreign-owned or two-way traders. We also control for log capital stock and the output of all large and medium-sized firms to isolate the impact of GVC activity.

Table 8 reports the results, where the total number of workers with vocational education is the dependent variable. The results vary between the fixed-effects and random-effects estimator. This could be because most of the variation in our explanatory variable of interest is between districts rather than within districts, as both GVC participation and human capital variables are changing slowly over the period of interest. Thus, the fixed effects model washes out most of the variation in employment in GVC-oriented firms.

We find a statistically significant impact of backward GVC participation on the size of the vocational educated workforce in the manufacturing sector. The fixed effects and random effects estimator also yields similar results for this measure of GVC activity. A 10 percentage point increase in backward GVC participation increases the number of vocational educated workers by 0.6%.[19]

Table 8: GVC Participation and the Number of Workers with Vocational Education in the Manufacturing Sector, District-Level Panel Regressions, Fixed Effects, and Random Effects Estimators

Variable	(1) Foreign emp[FE]	(2) Imp-exp[FE]	(3) GVC Back [FE]	(4) Foreign emp[RE]	(5) Imp-exp[RE]	(6) GVC Back [RE]
GVC measure	0.039	-0.025	0.041**	0.11***	0.15***	0.065***
	(0.038)	(0.032)	(0.018)	(0.026)	(0.023)	(0.023)
Log(Emp M&L)	-0.11	-0.095	-0.10	0.40***	0.38***	0.47***
	(0.072)	(0.070)	(0.070)	(0.035)	(0.031)	(0.028)
Observations	2,649	2,649	2,649	2,649	2,649	2,649

Emp M&L = total employment in medium-sized and large enterprises in the district; FE = fixed effects; GVC = global value chain; RE = random effects.
Notes: Standard errors (in parentheses). *p<.1, ** p<.05, *** p<.01. Column headings indicate the measure of GVC-oriented firms and estimator used.
Source: Authors' computations. Data: SAKERNAS and IBS.

[19] In another estimation approach, we apply the Arellano–Bond GMM estimator to estimate the parameters. We allow for one lag of the dependent variable and two lags of capital stock and output variables. We find effects of 2nd lag of capital stock on the number of vocational workers, but the results are not robust to alternative specification. The results are available from the authors upon request.

3.7. GVC activity and wages of vocational educated workers

Given the positive relationship between GVC activity and vocational education, it is natural to ask how wages are affected. In other words, is GVC activity in a province linked to a skills premium? To understand this, we use an ordinary least squares (OLS) regression model to explore the relationship between education and the hourly wages of worker i in district j and province p:

$$w_{ijp} = \beta_0 + \beta_1 voc_{ijp} + \beta_2 senior_{ijp} + \alpha X_{ijp} + \gamma W_{jp} + \theta_p + e_{ij}.$$

where w_{ij} is the hourly wage in logs;[20] voc_{ij} and $senior_{ij}$ are indicators for whether the worker obtained vocational education or senior secondary level education, respectively; X_{ij} is the set of individual characteristics including age, age-squared, and sex; and we also add provincial fixed effects θ_p. In addition, we include district-characteristics W_{jp} including total employment in medium-sized and large enterprises (in logs), the proportion of families in the district within 5 kilometres of a vocational school, and the total district population (in logs). While we cannot assign causal interpretation to the coefficients on education dummies, we examine how the coefficients change across samples of districts with increasing intensity of GVC activity (using the shift-share approach) and how the coefficients have evolved over time. We focus on younger workers aged 20–29 to see how the wages of young entrants to the labour market are being impacted by GVC activity.

The results for 2008 and 2015 are shown in Tables 9 and 10, respectively. In each table, we have four columns, progressively restricting the sample to locations with higher levels of GVC activity. The first column reports the results from the full sample of workers, column 2 reports the results from the top 40 GVC locations only, column 3 includes only the top 20 GVC locations, and column 4 includes only the top 10 GVC locations. In both years, we find that the wage premium of vocational and senior education is higher in locations with GVC activity than the Indonesian labour market as a whole, as the coefficients of the education dummies increase as we restrict the sample by the level of GVC activity in the district. Furthermore, the increase is much stronger in 2015 than it was in 2008. Interestingly, we find a slightly smaller

[20] SAKERNAS data ask workers to report cash earnings during the previous month and the total number of hours worked in the previous week. To calculate the hourly wage, we divide the monthly earnings by four times the number of hours worked.

education premium in the top 10 GVC locations compared with the top 20 locations in 2015, which is partly due to much greater supply of GVC workers in those top 10 locations.

When we consider the Indonesian labour market in manufacturing as a whole, workers with vocational education earn 29% (column 1 of Table 9) higher wages than those with up to junior secondary education (the base group) in 2008, and this difference is 45% in 2015 (column 1 of Table 10). Restricting the sample to the top GVC locations increases the wage premium by around 4 percentage points in 2008, with the largest estimated premium for vocational education in the GVC top 20 locations (column 3 of Table 9). This increase in the wage premium in GVC-intensive provinces is much stronger in 2015, when workers with vocational education in the top 20 GVC locations earn wages that are 61% higher than the base category, a 16 percentage point increase from the full sample (column 3 of Table 10).

Table 9: Wage Premium for Vocational Education in Areas with GVC Activity, 2008

Variable	(1) All districts	(2) GVC top 40	(3) GVC top 20	(4) GVC top 10
vocational	0.287***	0.330***	0.331***	0.312***
	(0.0353)	(0.0451)	(0.0556)	(0.0677)
senior	0.317***	0.323***	0.318***	0.267***
	(0.0419)	(0.0540)	(0.0676)	(0.0765)
age	0.0416	-0.0116	-0.0292	-0.171
	(0.0722)	(0.0907)	(0.111)	(0.109)
Age x age	-0.000229	0.000851	0.00131	0.00426*
	(0.00147)	(0.00186)	(0.00229)	(0.00224)
male	-0.0126	-0.0621	-0.0904	-0.0482
	(0.0433)	(0.0558)	(0.0652)	(0.0644)
Voc density	0.00148	0.00280*	0.00181	0.00189
	(0.00110)	(0.00156)	(0.00200)	(0.00291)
Log (Emp M&L)	0.00985	0.0262	0.0357	-0.0180
	(0.0151)	(0.0288)	(0.0474)	(0.0519)
Log (Pop)	0.00156	-0.0875	-0.132*	-0.191**
	(0.0491)	(0.0642)	(0.0659)	(0.0683)
_cons	7.592***	9.696***	9.084***	12.53***
	(1.121)	(1.418)	(1.827)	(1.846)
Province dummy	Yes	Yes	Yes	Yes
Observations	2,813	1,884	1,465	1,149
Number of districts	261	51	25	15

Emp M&L = total employment in medium-sized and large enterprises in the district; GVC = global value chain; Pop = total number of families in the district; Voc density = vocational school density.
Notes: Standard errors in parentheses. The sample includes employees aged 20–29 who are not self-employed and had positive earnings previous month. * p<.1, ** p<.05, *** p<.01.
Source: Authors' computations.

Table 10: Wage Premium for Vocational Education in Areas with GVC Activity, 2015

Variable	(1) All districts	(2) GVC top 40	(3) GVC top 20	(4) GVC top 10
vocational	0.448***	0.572***	0.611***	0.492***
	(0.0554)	(0.0821)	(0.119)	(0.125)
senior	0.467***	0.578***	0.607***	0.532***
	(0.0577)	(0.0818)	(0.111)	(0.139)
age	0.129	0.171	0.0187	0.191
	(0.101)	(0.132)	(0.169)	(0.202)
Age x Age	-0.00209	-0.00280	0.000344	-0.00322
	(0.00207)	(0.00269)	(0.00345)	(0.00416)
male	0.0770*	-0.0525	-0.0120	0.0242
	(0.0398)	(0.0500)	(0.0631)	(0.0776)
Voc density	0.0000952	0.00174	0.00614	0.0170
	(0.00170)	(0.00426)	(0.00556)	(0.00992)
Log (Emp M&L)	0.0410**	0.0460	0.000730	-0.151
	(0.0204)	(0.0528)	(0.0831)	(0.140)
Log (Pop)	-0.0187	-0.282*	-0.246	-0.582***
	(0.0626)	(0.144)	(0.159)	(0.193)
_cons	6.084***	8.986***	11.24***	14.89***
	(1.465)	(2.312)	(2.475)	(3.487)
Province dummy	Yes	Yes	Yes	Yes
Observations	1,534	759	488	316
Number of districts	306	47	24	14

Emp M&L = total employment in medium-sized and large enterprise in the district. GVC = global value chain; Pop = total number of families in the district; Voc density = vocational school density.
Notes: Standard errors in parentheses. The sample includes employees aged 20–29 who are not self-employed and had positive earnings previous month. * p<.1, ** p<.05, *** p<.01.
Source: Authors' computations.

Restricting the sample to the top 10 GVC locations actually yields a slightly lower estimate than the top 20 GVC locations, but these are still higher than the estimates from the full sample. The pattern for general senior education is only slightly different from that of vocational education, which is expected because GVC activity can increase the demand for both types of human capital.[21] This finding could be related to the fact that the relative supply of skilled workers is higher in these provinces.

[21] We also conduct this exercise for workers aged 20–65. The results are similar, although the change in coefficients is less pronounced. Results are available from the authors upon request.

The patterns observed in the data indicate that a higher extent of GVC activity is associated with a higher skills premium, which implies a positive relationship between GVC activity and human capital.

4. Conclusion

This paper empirically studied the relationship between GVC activity and human capital in the context of Indonesia's manufacturing sector. GVC firms operating in developing countries need to ensure that their workers have the appropriate skills. To meet these demands, firms participating in GVCs can thus directly train their workers or hire more skilled workers. From a worker's perspective, the prospect of employment in a GVC firm that pays higher wages could encourage workers to voluntarily obtain skills that will increase their chances to be hired.

The results showed that GVC activity at the district-sector increases the likelihood of individual workers having vocational education. Likewise, districts with a greater intensity of GVC activity have a larger number of manufacturing workers with vocational education. Both findings are robust when controlling for a district's density of vocational schools and using alternative measures of GVC integration. In addition, the results indicate that the wage premium for vocational education is higher in districts with greater intensity of GVC activity. Our results suggest that GVC activity is expected to boost the firm- or industry-specific human capital of the country, in particular through the demand effect. The expansion of opportunities for vocational education can, therefore, complement policies that aim to foster GVC participation in the country.

Our results also point towards greater policy focus on improving not only the supply of vocational schools, but also, importantly, the quality of vocational education. The net benefit of GVC activity to the economy would be even greater if it added to the pool of skilled workers by inducing greater skills acquisition, rather than only bidding away workers from other sectors (sectoral reallocation). In the former case, the economy can benefit from knowledge externalities created by a larger pool of skilled workers, including productivity gains, which can spill over into other activities. In the case of sectoral reallocation, a limited pool of skilled workers enjoys wage

increases as firms compete for their services. As the supply of skills has to keep up with the increased demand, the expansion of the GVC sector would be countered by a fall in skilled employment elsewhere. Although the sectoral reallocation of workers from less productive to more productive firms is an important source of gain from trade (Melitz, 2003), such a transition can be inefficient when labour markets are not well-functioning or are heavily fragmented geographically, as is the case in Indonesia. Future research could, therefore, extend our study and assess whether GVC activity leads to actual human capital formation.

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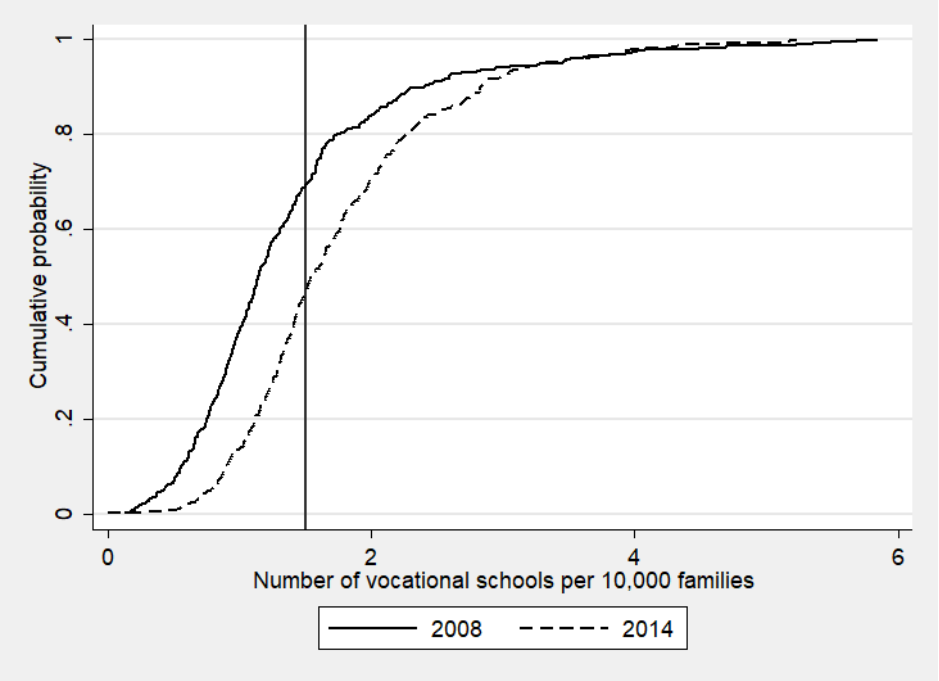
Appendix: Figure A1: Distribution of Districts by Number of Vocational Schools per 10,000 Families



Source: Authors' calculation from Village Potential Survey 2008 and 2014.

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